Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2018

Course Code: CH308

Course Name: CHEMICAL REACTION ENGINEERING-II (CH)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

Graph sheets may be used wherever necessary.

1 a) Illustrate the possibilities of non idealities in real reactor with suitable examples. (4)

b) Derive the relationship between Internal age distribution and exit age distribution. (4)

c) A sample of tracer hytane is injected as a pulse to a reactor and following Cpulse versus time data is obtained. Tabulate and plot E(t) data and find the fraction of material leaving the reactor that has spent between i) 3 and 6 minutes, ii) 7.75 and 9.75 min in the reactor (7)

t (min)	0	1	2	3	4	5	6	7	8	9	10	12	14
C(g/m^3)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

2 a) Prove that space time τ = residence time t_m for real reactors with RTD. (5)

b) Describe step tracer experiment and derive the relationship between residence time distribution E(t) and cumulative distribution function F(t). (6)

c) What are the desirable properties of a tracer used in RTD studies? (4)

3 a) Write short notes on i) dispersion model, ii) dispersion coefficient, iii) Damkohler number, iv) closed vessel boundary condition v) open vessel boundary conditions. (5)

b) The first order reaction A $\longrightarrow$ B is carried out in a 10cm diameter tubular reactor 6.36m in length. The specific reaction rate is 0.25 min^{-1}. Following are the results of a tracer test carried out in this reactor. Calculate the conversion using tanks in series model and compare with that of an ideal PFR. (10)

t (min)	0	1	2	3	4	5	6	7	8	9	10	12	14
C(g/m^3)	0	1	5	8	10	8	6	4	3	2.2	1.5	0.6	0

PART B

Answer any two full questions, each carries 15 marks.

4 a) Define catalyst. What are the desirable properties of a catalyst.List different types of catalyst with examples and describe the steps involved in a catalyst reaction. (7)

b) The mechanism of producing tertiary butyl alcohol (TBA) from water (W) and isobutene (I) using Amberlyst catalyst is given as follows (8)

I+S $\longleftrightarrow$ I.S, W+S $\longleftrightarrow$ W.S, W.S+I.S $\longleftrightarrow$ TBA.S +S,

TBA.S $\longleftrightarrow$ TBA+ S.

Derive rate law assuming surface reaction is rate limiting.

5 a) Discuss the steps involved in Langmuir –Hinshelwood approach of synthesizing a rate law for catalytic reactions with neat figure. (5)

b) Explain the process of estimating the diffusion and reaction limited regimes using i) Weisz-Prater criterion, ii) Mears criterion. (6)

c) Write short notes on i) effective diffusivity, ii) tortuosity. (4)

6 a) Derive the expressions for thiele modulus, internal effectiveness and overall rate of reaction for diffusion and reaction in spherical catalyst pellets. (12)

b) Illustrate any three types of heterogeneous reactions with examples. (3)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Compare shrinking core model with progressive conversion model explaining each and giving examples from real situations. (6)

b) Write short note on optimum temperature progression. (4)

c) Derive the expression for reaction time and conversion using un-reacted core model for fluid solid non catalytic reactions of spherical particles of unchanging size when diffusion through ash layer controls the overall rate of reaction. (10)

8 a) Calculate the time needed to burn to completion particles of graphite (Ro =5mm, ρ_B=2.2 g/cm^3, k$''$= 20cm/s) in an 8% oxygen stream. For the high gas velocity used, assume that film diffusion does not offer any resistance. Reaction temperature = 900^{0}C. (10)

b) Consider the reaction A+B $\longrightarrow$ 2R, ΔH_R = -50,000J at 25^0 C. At 25^0 C, the reaction is strongly exothermic. Calculate ΔH_R at 1025^0C and state whether the reaction is still exothermic at this elevated temperature. (10)

Data C_{pA} = 35 J/mol K, C_{pB}= 45 J/mol K, C_{pR}= 70 J/mol K.

9 a) Derive the expression for conversion for a non isothermal adiabatic reaction starting from the energy balance equation. Give the graphical representation of energy balance equation. (8)

b) Derive the general rate equation with mass transfer and reaction for fluid-fluid isothermal reactions. (8)

c) Explain the significance of Enhancement factor and Hatta modulus in fluid-fliud reactions. (4)

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